Appendix A

Examiner's Answer

Paper No. 29 of

SN 08/485,161

UNITED STATES DEPARTMENT OF COMMERCE
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BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Paper No. 29

Serial Number: 08/485,161
Filing Date: 6/7/95
Appellant(s): Benjamin Gebhart

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For Appellant

EXAMINER'S ANSWER

This is in response to appellant's brief on appeal filed January 10, 1997.

(1) Real Party in Interest

A statement identifying the real party in interest is contained in the brief. Mr. Gebhart is listed as the real party in interest. It is noted that this appears to be in some discrepancy with respect to "The Verified Statement (Declaration) Claiming Small Entity Status" as a "Nonprofit Organization" filed September 27, 1991 which listed the University of Pennsylvania as the Organization seeking reduced fees. It is unclear whether the University of Pennsylvania and/or Mr. Gebhart are/is the real party in interest.

(2) Related Appeals and Interferences

A statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

(3) Status of Claims

The statement of the status of the claims contained in the brief is correct.

This appeal involves claims 1, 3-7, 9 and 34-36.

Claims 2, 8, 10-33 and 37 have been cancelled.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

No amendment after final has been filed.

(5) Summary of Invention

The summary of invention contained in the brief is correct. It is basically a reiteration of claims themselves with quotations from the specification supporting those claimed limitations.

(6) Issues

The appellant's statement of the issues in the brief is correct.

(7) Grouping of Claims

The appellant's statement in the brief that certain claims do not stand or fall together is not agreed with because applicant has failed to specifically argue why the limitations found in dependent claims are patentable.

Applicant, in the brief, simply lists the limitations found in dependent claims 3, 4, 5, 6, 7, 9, 34, 35 and 36 one after another, reiterating them verbatim as shown, for example, on page 12 of the brief (Paper No. 28, see page 12). Accordingly, the examiner urges the Board to hold that the claims stand and fall together because applicant has failed to present reasons why these claims are separately patentable over the prior art.

It is believed by the examiner to be nearly hornbook law that reiterating the substance of the limitations of a series of dependent claims does not fulfill the requirement that the claims be separately argued in a way that will permit them to be treated as patentably distinct.

(8) Claims Appealed

The appealed claims are 1, 3-7, 9 and 34-36.

A substantially correct copy of these claims appears in an Appendix attached to appellant's brief. Note in each of claims 35 and 36, the word "substantially" should appear after the word "of" (see Paper No. 13 for the actual language of claims 35 and 36).

(9) Prior Art of Record

The following is a listing of the prior art of record relied upon in the rejection of claims under appeal.

Patents relied upon:

4,050,507	Chu et al.	9-1977
0,709,574	Reeber et al. (Canada)	5-1965

Publications relied upon:

"Pool Boiling Heat Transfer From Enhanced Surfaces to Dielectric Fluids", Marto, P.J. and Lepere, V.J., Transactions of the ASME, Vol 104, May 1982, pp. 292-299.

"The Emittance of Heavily Doped Microconfigured Silicon Surfaces", Hesketh, P.J., 1987 doctoral thesis in Electrical Engineering at the University of Pennsylvania.

(10) New Prior Art

No new prior art has been applied in this examiner's answer.

(11) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claims 1-3, 7, 9 and 34-36 are rejected under 35 U.S.C. § 103 as being unpatentable over Reeber in view of Chu and vice versa and the Marto and Lepere article and (optionally) the 1987 Hesketh dissertation.

Reeber (which is assigned to I.B.M. corporation, a leader in this refrigerant boiling technology for cooling semiconductor chips) teaches using a coated (or uncoated) conical hole in a surface to enhance boiling in liquid helium and hence heat dissipation from semiconductor chips (see Reeber page 2, lines 7-9). This is the exact problem that applicant is addressing. In fact, the "Background" section of applicant's specification gives an overview of the technology which is fairly accurate although slightly argumentative with regard to the Chu et al. reference (USPN 4,050,507 also assigned to I.B.M. corporation), discussed below.

Reeber puts a series of conical holes 14 in the surface of the plate 12 to promote the formation of bubbles and hence increase heat transfer (see Reeber page 2, lines 14-20). APPLICANT IS CLAIMING "DISCRETE NUCLEATION SITES HAVING A CONICAL CROSS-SECTION TAPERING TO A MINIMUM PREDETERMINED DEPTH." That claim limitation is an accurate description of what Reeber shows to be prior art in Reeber's Figure 2. Compare applicant's Figure 5 with Figure 2 of Reeber. Furthermore, Reeber (page 4, lines 20-28) suggests that providing more such conical imperfections produces more bubbles which in turn dissipates more heat.

Furthermore the limitation found in paragraph (b) of claim 1 that the refrigerant have a liquid contact angle of less than 5 degrees, effectively means many refrigerants except water (see Paper No. 4, page 4 which shows the liquid contact angle for helium, oxygen, hydrogen, nitrogen to be zero, and for FC-72 and R 113 to be 5 degrees, and for water to be 90 degrees). Helium, having a liquid contact angle of zero degrees is Reeber's preferred refrigerant. Clearly, the cavity cone angle in Reeber is greater than the liquid contact angle (i.e. zero) because the cavity cone angle must be some finite amount greater than zero or a "cone" would not exist. As shown in Figure 2 of Reeber, it is clearly between 30 and 45 degrees taking applicant's definition of cone angle disclosed with respect to applicant's Figure 5.

It is noted that applicant's own claim 1 by its own terms appears to exclude from patent coverage the two most commercially interesting refrigerants (R 113 and FC-72) since it claims refrigerant contact angles less than 5 degrees.

Needless to say Reeber's patent granted in 1965 shows the state of the art somewhat in its infancy, however it does teach many important aspects of applicant's claim 1. First, it discloses the conical cross-section tapering holes in a flat surface. Second, it discloses a refrigerant (helium) known to have a refrigerant contact angle of less than 5 degrees and a conical angle greater than the liquid contact angle. Third, it suggests providing many of these imperfections (i.e. "a predetermined minimum surface density") so as to increase heat transfer.

Admittedly, Reeber does not teach applicant's convenient method of making the surface recited in Claim 1, clause (a) "providing a polished, photo etched surface" however such a method of making is commonly employed in the art making these devices as specifically taught by the Hesketh dissertation discussed below and would have been obvious to use as a method of forming the Reeber structure given its conventionality and obviously inexpensive nature.

Furthermore, Reeber does not disclose whether or not his surface can be heated up to initiate nucleate boiling "with a

reversal of trend of less than 2 °C" and "without a temperature overshoot on the initial ascent", however those limitations are quantifications of knowledge already available in the prior art, specifically in the teaching of the Marto and Lepere reference.

This clause (c) of claim 1 represents one of the most troubling aspects of this case. It may well be that Reeber's device possesses these properties, which are deemed inherent to the surface itself, however because applicant has steadfastly refused to test anything but his own device for these obscure performance properties (particularly the "reversal of trend" a property so obscure that the examiner cannot find it reported at all in any piece of prior art) the examiner is in no position to definitively say that Reeber, Chu et al. or any other reference (i.e. Marto and Lepere) in the application is anticipatory or renders obvious the claimed subject matter.

The Board should be cognizant of the fact that claim 1, as now written, evolved over a whole series of parent applications, all now abandoned. Originally, claim 1 had mostly structural limitations which were relatively easy to find in the prior art. As claim 1 evolved, more and more performance criteria were added by applicant (including the obscure "reversal of trend" criterion) such that the examiner has had to rely more and more on argument to make his rejections, with applicant asserting the

patentability of his device was predicated on these performance criteria which much of the prior art had never been tested for.

In Paper No. 7, page 7, lines 12-23 this obscure "reversal of trend" is explained as follows:

The term "substantially without a reversal of trend" will be clear to one of ordinary skill in the art to mean the near absence of a negative swing in wall super heat, as described in the August 20, 1990 data curve in FIG. 16, as:

> ". . . the maximum decrease in wall-super heat with increasing heat flux, on the first ascent of the boiling curve. Generally, the wall-super heat reversal of trend is the hystersis in the boiling curve." (emphasis supplied)

What is clear from page 18, lines 24-33 of the specification is that a small "reversal of trend" generally equates with a "small hystersis" in the boiling curve even though, technically speaking, those two quantities are different as is shown in applicant's FIG. 16. The prior art, (Marto and Lepere, in particular) while it does not test for reversal of trend specifically, is very aware that "small hystersis" is desirable. For example the Marto and Lepere article on page 297, column 1, lines 14-15 states:

"Thermoexcel-E surfaces exhibit very little temperature overshoot and hystersis following surface aging C and D."

The reader should look carefully at Fig. 6 on page 296 where it is evident that with respect to RUN 8 (Surface Aging C) and

RUN 9 (Surface Aging D) that the data illustrated by the hollow squares (illustrating increasing heat flux for RUN 8) and solid squares (illustrating decreasing heat flux for RUN 8) and hollow triangles (illustrating increasing heat flux for RUN 9) and solid triangles (illustrating decreasing heat flux for RUN 9) all show very little temperature overshoot and hystersis (i.e. that which is being claimed in claim 1, paragraph (c)). Figure 7 should also be examined which shows in RUNS 19 (Surface Aging D) and 21 (Surface Aging C) virtually no discernible overshoot or hystersis.

Furthermore, Surface Aging C (i.e. Run 8, in Fig. 6 and Run 21, in Fig. 7 and Run 33 in Fig. 8, all pertaining to testing in R-113, a.k.a. Freon 113; and Run 14 in Fig. 10 and Run 18 in Fig. 11 and Run 30 in Fig. 12, all pertaining to testing in FC-72) bears an uncanny resemblance to applicants own surface aging treatment (as will be discussed below) and may well account for the fact that both applicant and Marto & Lepere attain similar results, namely the claimed performance in paragraph (c) of claim 1. The aforementioned Runs (i.e. Runs 8, 21, 33, 14, 18 and 30) in Marto and Lepere all exhibit no discernible hystersis (and hence negligible "reversal of trend", given the fact that applicant has conceded in the specification page 18, lines 24-33, that to know one, "small hystersis", is to know the other, "small

reversal of trend") and no significant overshoot (i.e. the subject matter claimed in claim 1 paragraph (c)).

As the Board is well aware, the PTO has no test facilities at its disposal to perform the necessary tests to determine whether or not certain prior art inherently possesses some performance property which an applicant has disclosed with respect to his device but which a prior art reference does not because it was never tested in that particular manner. Under these circumstances the burden of testing falls on the applicant to disprove the examiner's prima facie case of obviousness which has been clearly made here. Applicant has made virtually no effort to test any of the prior art cited by the examiner to see if performs the same as the embodiments encompassed by these claims.

While applicant's Figures 14-16 purport to show testing against Marto and Lepere, the comparison is illusory because applicant's Figures 14-16 only plot the data for the Thermoexcel-E coating which were treated using "Aging A", not the far more pertinent "Aging C" or "Aging D" shown in Figure 11 of Marto and Lepere. It is interesting to note that applicant fails to even specify what particular test data from Marto and Lepere was lifted from that reference and re-plotted onto applicant's Figures 14-16 (see page 19 of the specification). The examiner believes it must have been Run 17 (Surface Aging A) from Figure

11 which has an enormous hystersis compared to Run 18 (Surface Aging C) and Run 16 (Surface Aging D).

In view of Marto and Lepere's teaching it would have been obvious to have used the surface aging process "C" in the Reeber prior art as well as any of the other features of those surfaces permitting one to have attained the advantageous small reversal of trend and low overshoot disclosed by Marto and Lepere in reference to the aged surfaces C (specifically disclosed with respect to Runs 8, 21, 33, 14, 18 and 30). The examiner also believes that Reeber alone may answer to every limitation found in claim 1 paragraph (b) and (c) and it is only applicant's refusal test the closest prior art that makes a definitive conclusion impossible to reach.

With regard to claim 2, Chu (also assigned to I.B.M.) teaches in the same art using cavities deeper than 6um (in applicants aspect ratio range). The have made the conical cavities in Reeber's device with the aforementioned dimensions of Chu would have been obvious because they work so well in Chu. Alternatively, to have used conical holes in Chu as taught by Reeber would have been obvious because they are easy to make and work well in Reeber. While it is true that Chu, in a preferred embodiment uses a cavity that is somewhat constricted at the surface (see Figure 12 of Chu, specifically constricted diameter at the outer surface) to help hold a bit of vapor in the cavity,

it is clear from looking at Figures 2-6 that much of the advantageous small hysteresis can be attained with conical shaped cavities.

Regarding polishing and etching, the Hesketh dissertation concedes this to be a well know method of making heat exchangers (see page 43, lines 4-6). To have formed this particular method of etching a surface in place of the methods of forming the surface as taught by either Chu or Reeber because it is quick and simple would have been obvious to one ordinary skill in the art. Further the use of the surface to a refrigerant or cryogen would have been obvious as suggested by the references themselves. Finally Marto and Lepere teach aging the surfaces to completely avoid overshoot on the initial ascent, something obvious to do to the prior art discussed above.

Applicant's key point in traversing this art rejection is found on page 10 of Paper No. 13, six lines up from the bottom: "These techniques [the aging techniques employed in the Marto and Lepere article which comprise aging (for surface "C") "by preboiling it at 30 kW/m^2 for 1 hour (while the heater was on) followed by immediate operation"], in no way, can be equated with Applicant's limitations of flooding its nucleation sales with a refrigerant *prior* to heating the surface to the preselected boiling point of the refrigerant" (emphasis in the original). Applicant's purported statement of fact is false. Aside from

that applicant alleges this limitation is in claim 1 but the Examiner cannot find anything close to this language in claim 1. The examiner is having trouble reconciling applicant's comments about Marto et al. because on page 14, line 24-30 of the specification, applicant "ages" his surface (i.e. by boiling the bulk fluid for two hours and activating the heated test surface to 60% of the critical heat flux for one hour as disclosed in the specification page 14, lines 25-30) in much the same way as disclosed in the Marto and Lepere article.

Also in the specification applicant is very equivocal about whether the test surface was actually de-gassed, to wit: "This procedure [boiling the bulk fluid for two hours and activating the heated test surface to 60% of the critical heat flux for one hour] de-gassed the test fluid and possibly the nucleation sites on the microconfigured test surface." (see specification, page 14, lines 28-30)

Not only does applicant use a surface aging process that bears a striking resemblance to the one Marto and Lepere disclose as having the property of "avoiding overshoot on the initial ascent" and "hystersis" (as applicants have conceded to be true in Paper No. 13, page 9, lines 16-23, and as claimed by applicant in claim 1, paragraph (c)), but applicant isn't even sure if his nucleation sites (i.e. the "conical cross-sections") are "substantially flooded" as he claims in claim 1, paragraph (b).

Given the similarity of Marto's surface preparation procedure and the performance shown by Marto, the examiner cannot in good faith conclude that they are different. Applicant, for his part, has refused to test his device against the relevant Marto and Lepere prior art. Instead applicant has tested his device against a perfectly flat surface, a virtually meaningless test since perfectly flat surfaces (lacking any nucleation sites) are known to perform miserably compared to any sort of enhanced surface.

Claims 1, 3-7, 9 and 34-36 are rejected under 35 U.S.C. § 102(b) as anticipated by or, in the alternative, under 35 U.S.C. § 103 as obvious over the Marto and Lepere article particularly with respect to aged surfaces C and D in Figures 6-8.

The discussion above of Marto and Lepere is incorporated here by reference. Absent testing by applicant to prove the superiority of his own device, the examiner can see no discernible difference between the performance of aged surfaces "C" and "D" of Marto and Lepere and that of applicant's claimed device.

(12) New Ground of Rejection

This examiner's answer does not contain any new ground of rejection.

(13) Response to argument

Applicant's traverse of the examiner's rejections amount to an unsubstantiated assertion that the surfaces of the prior art and that formed consistent with applicant's claimed limitations perform differently. Applicant has never tested his device against the relevant prior art and therefore is in no position to prove his assertions.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

JOHN K. FORD
PRIMARY EXAMINER
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J. FORD:th
April 15, 1997

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